Recognition of Scientific and Artistic Process of Product Design in Innovations of Al-Jazari with an Emphasis on the Combined Lock

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Introduction
Badi' al-Zaman al-Jazari was a scientistof sixth century AH (12th century AD). He lived in the Diyarbakir region and illustrated 50 innovative and complementary designs for automated devices in his book. He is known as the father of robotics and a pioneer of mechanical engineering in the golden age of Islam; however a large part of his creativity and innovationsin his designs has been ignored. Examining al-Jazari'sdesign process from the perspective of both mechanical engineering and industrial design reveal new dimensions of this Muslim innovator's creativity. A look at his designs provides a new understanding of the turning point and development of his evolved style of product design. About 850 years ago, Jazari accomplished the most appropriate product designingin at least fifty devicesthrough a careful combination oftwomajor facets of product designing— i.e. mechanism and creativity.

Materials and Methods
The method of this research is descriptive-analytic and uses a qualitative approach to examine the process of product designing as carried out by al-Jazari in a combined lock. The method of data collection is the library based and conducted through direct observation and the evaluation of the product. The population under study is the devices designed by Jazari; the combined lock was examined as a specimen. This product was a coded lock that uses the consonance of twelve letters to secure the lid of a special chest and lock it. This lock, which was installed on special chests, could complete the safest storage facilities for protecting documents and treasures. This study focused on the combined lockto analyze it comprehensively. The main question of the research was to explore how the scientific and artistic process of product designing can be evaluated in the invention of the Jazari's combined lock.

Results and Findings
What is obtained from the analogy of product design processes in mechanical engineering and industrial design is generally summarized in the field of expertise. Both sciences focus on responding to a need by creating a response. However, the response in mechanical engineer is to design and create a mechanism and system so that a mechanism can be tested. In industrial designer is to design an identity for industrial products. This is done with the aim of creating and enhancing the most effective connection between humans and industrial products. The index of measuring is form, aesthetics, ergonomics, meaning and human values, the degree of effective connection with the user, and the share of success in the commercial market. In this research, al- Jazari's combined lock was

evaluated. Al-Jazari’s had system included a central hub connected to four locks, each of which consisted of three disks. This system had millions of possible states that were practically impossible for someone who did not know the code to decipher it; this feature made a masterpiece of this lock in terms of security equipment. Afterwards,al-Jazari proceeded to build a complete and functional prototype of his device. He, then, provided detailed descriptions of the product and used numerous images to facilitate the understanding of its appearance, structure, components, parts, and intricate mechanisms. These images not only increased the visual appeal of the product but also made it easier for the audience to understand the function and construction of the device. This method of documentation demonstratedal-Jazari’s scientific and engineering approach as well as his special attention to details and knowledge transfer.

Conclusion

Responding to the need of protecting valuable documents and assets, al-Jazari succeeded in designing a combined lock, offering an extremely safe and secure product. Although this innovation was formed based on the completion of the ideas and achievements of his predecessors, it became a unique work with creative development and personal ingenuity. Henot only ensured the physical security and psychological peace of the owner of the valuable boxes but also paid attention to the aesthetic appeals of the product. The use of forms inspired by nature and plant and animal motifs in the design of the components, the combination of square and circle forms in the mandala pattern that symbolizes the connection between earth and sky as well as the cycle of evolution, and the use of the symbolic number 12 in cryptographic situations are proofs of this precision and elegance. Like any outstanding designer, he has created a systematic and structured product by combining engineering methods, semiotics, and aesthetics, which reflects his deep understanding of the principles of design and engineering. Although he lived about 850 years ago, the process of designing and writing the descriptions and details he covered in his book is similar to the scientific and artistic process of product designing today and has inspired many designers after him.

Keywords: combined lock, al-Jazari, product design process, industrial design, mechanical engineering.